Partial Translation of JP 11-219152 A

[Scope of Claims for Patent]

[Claim 1] A plasma display device characterized by comprising: driving means that drives the plasma display panel on the basis of an externally applied video signal; a plasma display panel driven by said driving means to carry out displaying; means that removes a low frequency component of said video signal; histogram calculation means that creates a histogram for each gray scale range of the video signal whose low frequency component is removed; judgment means that makes judgement on an image with drastic luminance changes on the basis of the histogram created by said histogram calculation means; and control means that controls said driving means on the basis of a result of the judgement by said judgement means.

[Claim 2] The plasma display device as recited in claim 1, characterized in that the number of retaining pulses in said driving means is controlled by said control means.

[Claim 3] A plasma display device characterized by comprising: video signal processing means that processes an externally applied video signal; driving means that drives the plasma display panel on the basis of the video signal processed by said video signal processing means; a plasma display panel driven by said driving means to carry out displaying; means that removes a low frequency component of the video signal

processed by said video signal processing means; histogram calculation means that creates a histogram for each gray scale range of the video signal whose low frequency component is removed; judgment means that makes judgement on an image with drastic luminance changes on the basis of the histogram created by said histogram calculation means; and control means that controls said video signal processing means on the basis of a result of the judgement by said judgement means.

[Claim 4] The plasma display device as recited in any of claims 1 to 3 characterized by comprising storage means that stores control level information of said control means for a definite period after a main power source is off.

[Claim 5] A plasma display device characterized by comprising: driving means that drives the plasma display panel on the basis of an externally applied video signal; a plasma display panel driven by said driving means to carry out displaying; means that removes a low frequency component of said video signal; histogram calculation means that creates a histogram for each gray scale range of the video signal whose low frequency component is removed; judgment means that makes judgement on an image with drastic luminance changes on the basis of the histogram created by said histogram calculation means; and communication means that outputs a result of the judgement by said judgement means to outside.

[Claim 6] The plasma display device as recited in any of claims

1 to 5, characterized by comprising panel characteristics storing means that stores preliminary measured characteristics of the plasma display panel, and characterized in that a judgement reference value of said judgement means is variable depending on the contents of said panel characteristics storing means.

[Claim 7] The plasma display panel as recited in any of claims 1 to 6, characterized by comprising coefficient storing means that provides said control means with different control coefficients depending on whether the applied video signal is a television signal or a computer signal.

[Claim 8] The plasma display device as recited in claims 1 to 7, characterized by comprising temperature detecting means that detects an atmospheric temperature of the plasma display device, and characterized in that the judgement reference value of said judgement means is corrected depending on an output of said temperature detecting means.

[Claim 9] A method of controlling a temperature of a plasma display panel, characterized by comprising the steps of: removing a low frequency component of a video signal; creating a histogram, by histogram-calculation, for each gray scale range of the video signal whose low frequency component is removed; judging an image with drastic luminance changes on the basis of the histogram created by said histogram calculation means; and controlling luminance of the plasma

display panel on the basis of a result of the judgement by said judgement step.

[Claim 10] The method as recited in claim 9, characterized in that the number of retaining pulses of the plasma display panel is controlled by said control step.

[Claim 11] The method as recited in claim 9, characterized in that an amplitude of a video signal input to the plasma display panel is controlled by said control step.

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[0033]

[Embodiments of the Invention] In a plasma display device being an embodiment of the present invention, the luminance of a PDP is controlled by detecting an image which causes a temperature difference in the PDP by removing a low frequency component of a video signal and evaluating a histogram for each luminance of a sampled video signal, and hence the temperature difference in the PDP is reduced.

[0034] Further, since the luminance of the PDP is controlled by controlling the number of retaining pulses, the temperature difference in the PDP is reduced by a simple circuit configuration.

[0035] Since the luminance of the PDP is controlled by controlling video signal processing means, the temperature

difference in the PDP is reduced by merely adding a few circuits to a conventional plasma display device having video signal processing means.

[0036] By holding the control information of control means in storage means for a definite period even after a main power source is off, the temperature difference in the PDP is reduced by suitable control even if the main power source is connected again after a comparatively short time.

[0037] Moreover, by outputting the result of judgement by judgement means outside to control a video signal on the side close to an external signal source, the temperature difference in the PDP is reduced without requiring any special control circuit on the side close to the plasma display device.

[0038] In addition, by storing preliminary measured characteristics of a plasma display panel in panel characteristics storing means, and varying a judgement reference value of the judgement means depending on the contents of the panel characteristics storing means, the temperature difference in the PDP is appropriately reduced in accordance with respective temperature characteristics even if there is a variation in temperature characteristics for each panel in the PDP, or if there are variations in temperature characteristics in some parts in the panel.

[0039] Also, by varying a control coefficient which is applied to the control means by coefficient storing means, depending

on whether an externally applied video signal is a television signal or a computer signal, the temperature difference in the PDP is reduced with a minimal effect on image quality by virtue of a display corresponding to the type of signals.

[0040] Further, by correcting a judgement value of the control means on the basis of an output of temperature detecting means that detects an atmospheric temperature of the plasma display device, the temperature difference in the PDP is effectively reduced in accordance with environments and circumstances where the device is installed and used.

[0041] A detailed description will now be made on the present invention on the basis of the drawings showing its embodiments. Embodiment 1: First of all, Embodiment 1 will be described. Fig. 1 is a structural diagram of a plasma display device being Embodiment 1 of the present invention. In Fig. 1, a reference numeral 1 denotes a driving circuit, 2 denotes a plasma display panel (PDP), 3 denotes a mean value calculation part, 4 denotes a region dividing part, 5 denotes a histogram calculation part, 6 denotes a judgement part, and 7 denotes a control part.

[0042] An operation will then be described. First, video signals and synchronization signals are input to the driving circuit 1 as well as the mean value calculation part 3. Similarly to a conventional plasma display device, the driving circuit 1 stores the input video signals into a frame memory in the driving circuit 1, then reads the stored signals divided

for each subfield, and applies driving pulses to an X electrode, a Y electrode and an address electrode of the PDP 2, respectively, like the conventional plasma display device. The PDP 2 emits light on the basis of the driving pulses applied from the driving circuit 1 and displays an image.

[0043] In the mean value calculation part 3, first, as a preprocessing, R, G, B of color video signals are averaged to form a black and white video signal of only luminance information. After that, with respect to this black and white video signal, a mean value of the number of pixels determined respectively in longitudinal and lateral directions are evaluated, so that a video signal which is sampled with a smaller number of pixels than the original video signal is obtained, and a low frequency component of the video signal is also removed. The low frequency component of the video signal is removed in order to eliminate any influences by luminance distribution in a relatively small area. If the PDP is used as a computer display, for example, letters or characters are often displayed on a screen. Letters or characters include both pixels with a high luminance value and a low luminance value in a relatively small area. Even though both the high luminance pixels and low luminance pixels exist in the relatively small area, they are not considered to cause a problem of a large difference in temperature. This is because the heat of a panel is conducted at a relatively high speed in the small area, and

hence a large temperature difference is not produced in such a small range.

[0044] Fig. 2 is a diagram for use in explaining an example of the operation of the mean value calculation part 3, in which a video signal corresponds to XGA (1024 by 768 pixels). In Fig. 2, (a) represents a video signal of one frame, indicating an enlarged upper left part of an image composed of 1024 pixels in a lateral direction and 768 pixels in a longitudinal direction; and (b) represents a sampled video signal of one frame after being processed by the mean value calculation part 3, which signal is composed of 64 pixels in a longitudinal direction and 48 pixels in a lateral direction. The mean value calculation part 3 evaluates a mean of luminance values in the range of hatched area in Fig. 2(a), i. e., over 16 by 16 pixels, to obtain a luminance value of the pixels in the hatched area at the corresponding position in Fig. 2(b). This processing is repeated over the entire one frame, thereby obtaining luminance values of all the pixels in Fig. 2(b).

[0045] Evaluating the mean of the luminance values of the 16 pixels in both the longitudinal and lateral directions makes it possible not to affect calculation of such luminance distribution that pixels with high luminance and those with low luminance exist together in the range of 16 by 16 pixels as will be described later. In addition, since the number of pixels of the video signal to be processed decreases to one

256th of the original image, it becomes possible to decrease a circuit scale necessary for a processing which will be described later or increase a processing speed. As to about how many pixels should be used to evaluate the mean of luminance values, it depends on the number of all pixels in the PDP, the size of the PDP, and the heat conductivity of materials constituting the PDP.

[0046] Then, the region dividing part 4 divides the sampled video signal processed by the mean value calculation part 3 into several regions as shown in Fig. 3. In the example of Fig. 3, the sampled video signal composed of 64 pixels in the lateral direction and 48 pixels in the longitudinal direction is divided into 12 regions. Processing each divided region as will be described later makes it possible to find which region of video an image with a large luminance difference to be detected belongs to. Thus, it is possible to make judgement as to which position in the PDP the temperature difference is produced, by the processing as will be described later.

[0047] Then, the histogram calculation part 5 evaluates by calculation a histogram of a luminance value for each region obtained by the region dividing part 4. This will now be described with reference to Figs. 4 and 5. Fig. 4 is a diagram showing one example of the regions and a histogram corresponding thereto, having no gradient in luminance. Fig. 5 is also a diagram showing one example of the regions and a

histogram corresponding thereto, having a large gradient in luminance. In each of Figs. 4 and 5, (a) is one example of the regions, and (b) is the histogram evaluated from (a). For simplification, the luminance value is divided into three ranges of low luminance, medium luminance and high luminance. In Figs. 4(a) and 5(a), pixels colored in black have low luminance, those in hatched area have medium luminance, and those in white have high luminance. The histograms of Figs. 4(a) and 5(a) are shown in Figs. 4(b) and 5(b), respectively. In practice, a histogram is made by dividing a luminance value into more ranges. When the luminance value is divided into eight sections, for example, assuming that luminance is 256 gray scales (0 to 255), the luminance value may be divided into eight sections such as 0 to 31, 32 to 63, 64 to 95, 96 to 127, 128 to 159, 160 to 191, 192 to 223 and 224 to 255 to make the histogram of the number of pixels in the respective ranges of those divided luminance values.

[0048] Then, the judgement part 6 makes judgement as to whether there is a large luminance gradient on the basis of histogram data obtained from the histogram calculation part 5 by a method which will be described later. Since there is one histogram for each divided region, first, judgement is made as to the histogram for each region, then the luminance values in the respective ranges of the histograms for two adjacent regions are added together to combine two histograms, and judgement

is also made as to those combined histograms by a method which will be described later. Combining the histograms of those two adjacent regions enables detection of a luminance gradient over the two adjacent regions. Further, addition of the luminance values in the respective ranges for all histograms in one frame makes it possible to obtain a histogram of the entire video signal in one frame. If judgement is also made as to the histogram of the entire one frame by the method which will be described later, more reliable judgement can be made.

[0049] A detailed standard for judgement will now be described. In an image with a large luminance gradient, both pixels with high luminance and those with low luminance exist in one histogram, but there are few pixels with medium luminance. Accordingly, when the proportion of the number of pixels with medium luminance for all pixels is smaller than a certain value, and the number of pixels with high luminance is greater than a certain value, it is judged that there is a large luminance gradient.

[0050] When such judgement is made on the histogram of each region, the combined histograms of two adjacent regions, and the histogram of the entire image, as has been described above, and it is thus judged that there is a large luminance gradient in at least one histogram, the judgement part 6 outputs a signal indicating "there is a luminance gradient." to the control part 7. On the other hand, when it is judged that there is no

luminance gradient in the judgement as to all the histograms, the judgement part 6 outputs a signal indicating "there is no luminance gradient." to the control part 7.

[0051] Finally, when a window image is displayed, the control part 7 controls, on the basis of the result of the judgement obtained by the judgement part 6, the driving circuit 1 to reduce the number of retaining pulses in each subframe, thereby decreasing the display luminance of the PDP 2 and thus enabling suppression of the production of temperature differences in the panel. As luminance is in proportion to the number of pulses, when it is desired that luminance is set to x % where luminance in a standard state (a state that luminance control is not carried out) is set to 100 %, a relation $Pc = Ps \times x/100$ may be satisfied where Ps is the number of pulses in the standard state (where luminance control is not carried out), and Pc is the number of pulses when luminance control is carried out. Since the pulse number is actually an integer, the control is carried out stepwise. Since a large temperature difference in the PDP occurs while a video signal having a luminance gradient for a certain period of time is continuously displayed, the actual control should be carried out depending on the presence or absence of the luminance gradient for a certain period of time in the past. A detailed control method will now be described with reference to Fig. 6.

[0052] Fig. 6 is a flowchart showing the operation of the

control part in Embodiment 1 of the present invention. S001 denotes initialization which is executed only once such as when a power source is on in the plasma display device. W_CNT and NW_CNT are variables whose values are integral values held inside the control part 7. Their respective variables include information as to the luminance gradient in frames in the past. In S001, these variables W_CNT and NW_CNT are initialized, so that the variables W_CNT and NW_CNT are provided with 0 and a certain integer WMAX as initial values, respectively.

[0053] In subsequent S002, a result of judgement corresponding to one frame as to the presence or absence of luminance gradient is acquired from the judgement part 6. In B001, on the basis of the result of judgement acquired in S002, the operation of the control part branches into S003 when there is a luminance gradient or S007 when there is no luminance gradient.

[0054] A description will first be made on the case where there is a luminance gradient, that is, the operation proceeds to S003. In S003, both variables W_CNT and NW_CNT are incremented by one. In subsequent B002 and S004, WMAX is substituted in the variable NW_CNT when the variable NW_CNT is not smaller than WMAX. In B003, the operation flow proceeds to S005 when the variable W_CNT is not smaller than WMAX. After 0 is substituted in the variable W_CNT, the luminance of the PDP 2 is controlled by control of the driving circuit 1 in S006. In S006, a luminance control value is decremented by one step.

In other words, the number of retaining pulses in the driving circuit 1 decreases by the predetermined one step which has been set in advance. As a result, when the control value is lower than a predetermined lower limit value, the control part carries out no operation. At the end of the foregoing processing, the operation returns to S002 where the control part standbys until it acquires a result of judgement on a subsequent frame.

[0055] A description will now be made on the case where there is no luminance gradient, that is, the operation proceeds to S007. In S007, both variables W_CNT and NW_CNT are decremented by one. In subsequent B004 and S008, 0 is substituted in the variable W_CNT when the variable W_CNT is not larger than 0. In B005, the operation proceeds to S009 when the variable NW_CNT is not larger than 0. After WMAX is substituted in the variable NW_CNT, the luminance of the PDP 2 is controlled by control of the driving circuit 1 in S010. In S010, a luminance control value is incremented by one step. As a result, when the control value is larger than an upper limit value (the number of pulses in the standard state), the control part carries out no operation. At the end of the foregoing processing, the operation returns to S002 where the control part standbys until it acquires a result of judgement on a subsequent frame.

[0056] The control is made by repeating the foregoing processing for every frame. This control method will now be

described with reference to Fig. 7. Fig. 7 is a diagram showing one example of the operation of the control part in Embodiment 1 of the present invention and graphing the circumstances of control of the variables W_CNT and NW_CNT and a control value (the standard state is assumed to be a 0 step). The abscissa indicates time represented by the number of frames. In the example of Fig. 7, after the state where there is a luminance gradient continues for 25 frames, this state changes to the state where there is no luminance gradient. As will be understood from Fig. 7, as the luminance gradient present state continues for WMAX frames, the control is made to lower the control value by one step. The control is made for every WMAX frames even in the most rapid case. Even if an image changes rapidly for several frames, it does not affect the control, so that accurate control is made. In the graph of Fig. 7, a relation WMAX = 10 is set for simplification; however, it is desirable in fact that the luminance changes about once in several seconds in order to prevent flickers, so that WMAX is about several hundreds.

[0057] Because of such control as above, the luminance is lowered stepwise when an image that has a luminance gradient to cause a temperature difference in the PDP is displayed, while the luminance is raised stepwise (returned to the standard state) when an image without any luminance gradient is displayed. This makes it possible to prevent the production

of a large temperature difference in the PDP.

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